Chapt 21: The Lymphatic and Immune Systems

Goals

1. Discuss the organization of the lymphatic system, including the vessels, principal lymph nodes, thymus, and spleen
2. Explain the relationship between the lymphatic and circulatory systems, and the role of lymphoid tissue structures and lymphocytes in the body's defense
3. An introduction to the Immune System

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LAS POSITAS COLLEGE

Overview of the Lymphatic System

Includes, vessels, fluid, and nodes or nonsecreting "glands".

Lymphatic vessels convey fluid from the periphery to the veins.

The fluid, lymph (=clear water), is what seeps out of the blood at the peripheral capillaries. Composition is similar to plasma without as much protein

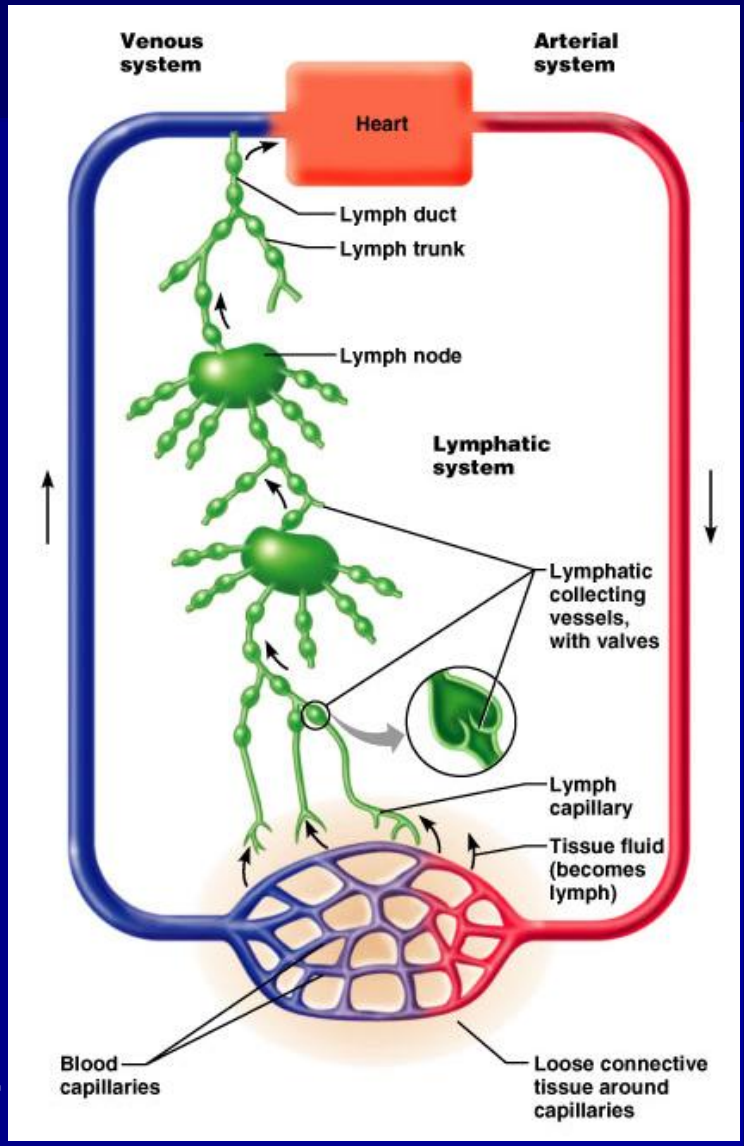


Fig 20.1

Overview of the Lymphatic System

Lymphatic organs or tissues ("glands" is a misnomer) are filtering areas and arenas of lymphocyte maturation and competency.

Accessory to cardiovascular system, thus there are two drainage systems.

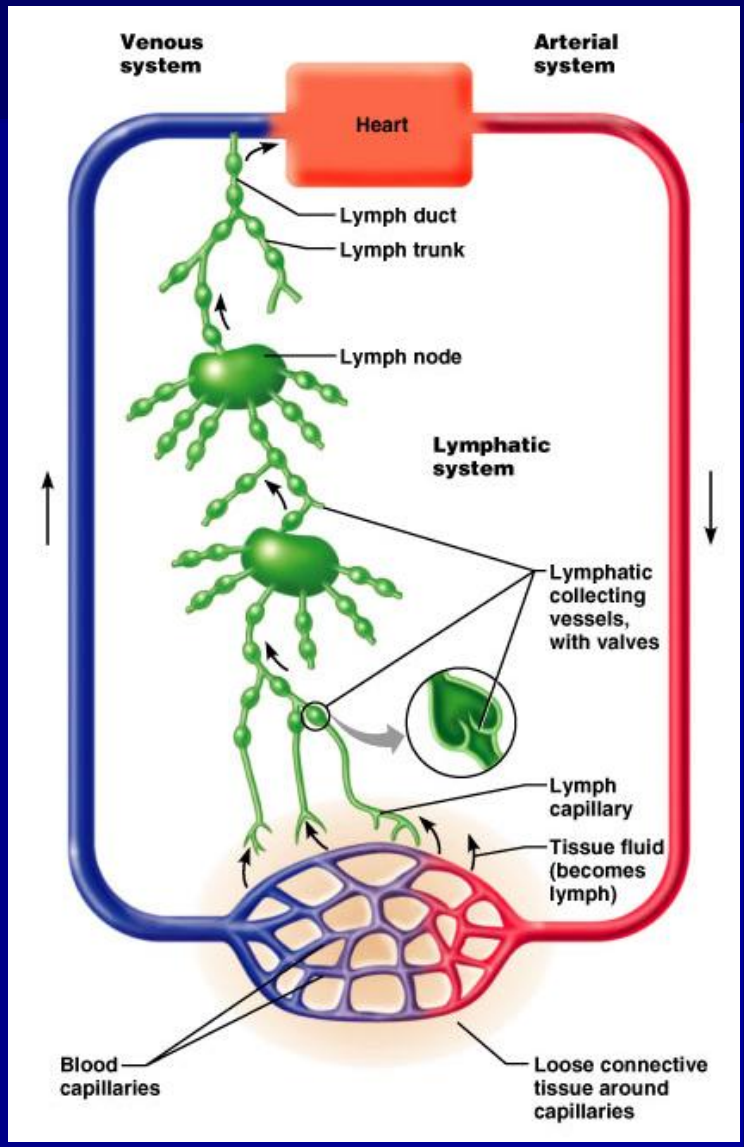


Fig 20.1

Major Functions of the Lymphatic System

1. Filtration of lymph
2. Return of leaked fluid to cardiovascular system
3. “Education” and production of immune system lymphocytes
4. Transport of digested lipids from small intestinal lacteals

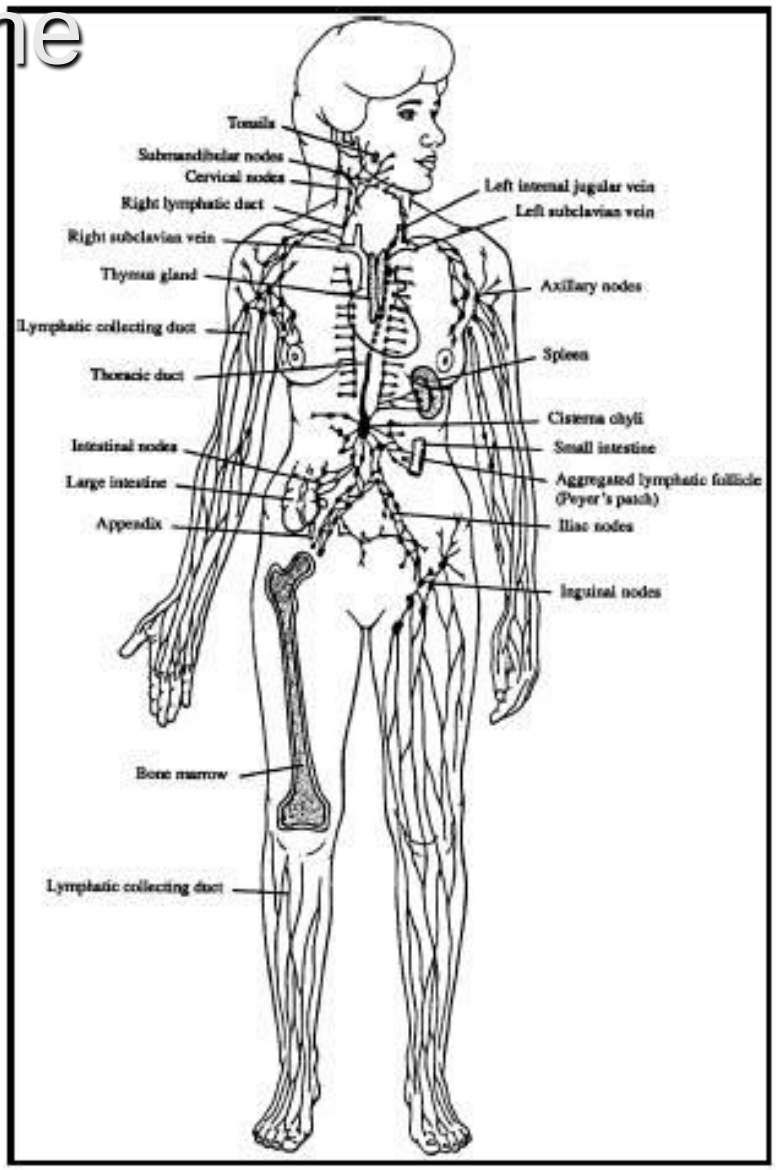
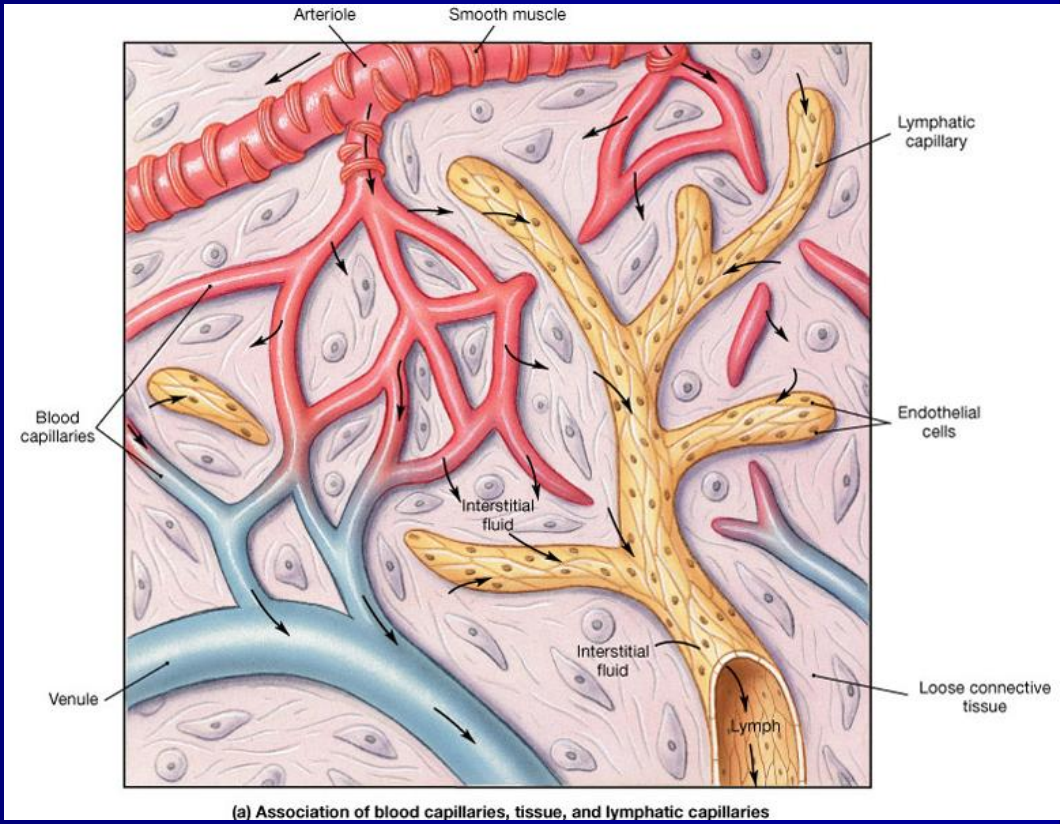


Fig. 8.8. Main organs of the human lymphatic system (redrawn from Tortora[853]).

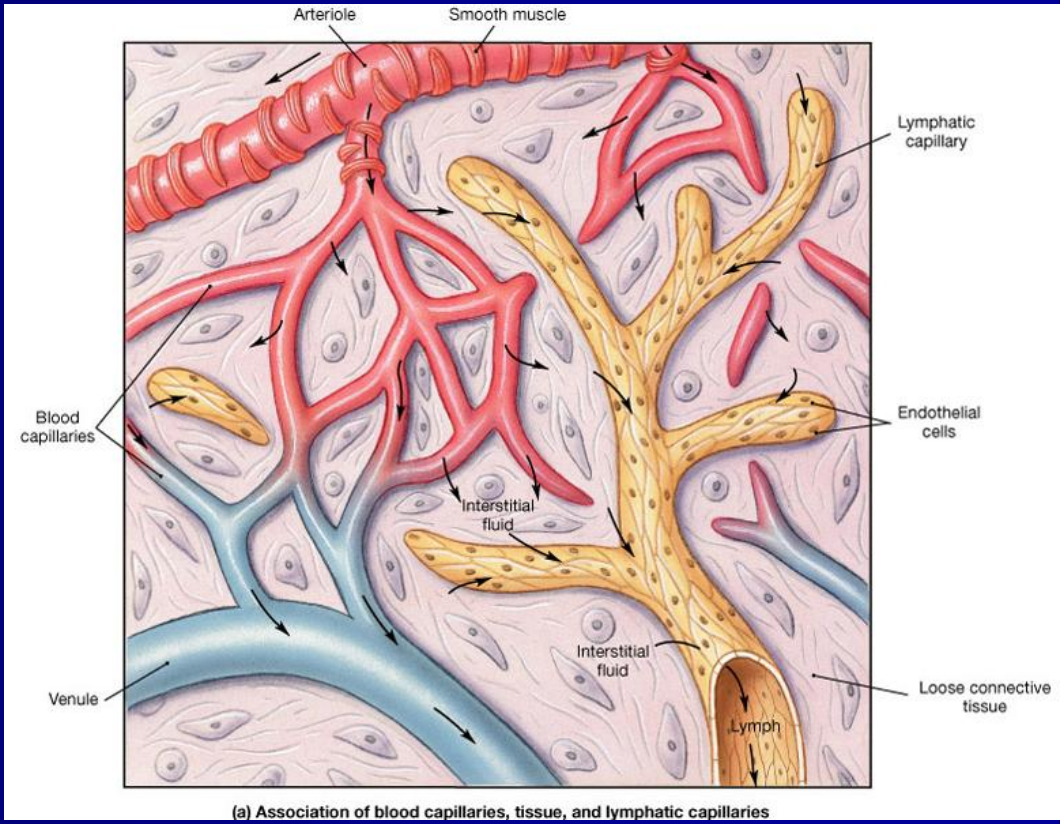
Lymph Capillaries

- Thin walled endothelium (no BM) with periodic one way valves. In general ,they parallel veins.
  - Usually not visible on tissue sections
- Lymph capillaries converge into collecting vessels



Lymph Capillaries

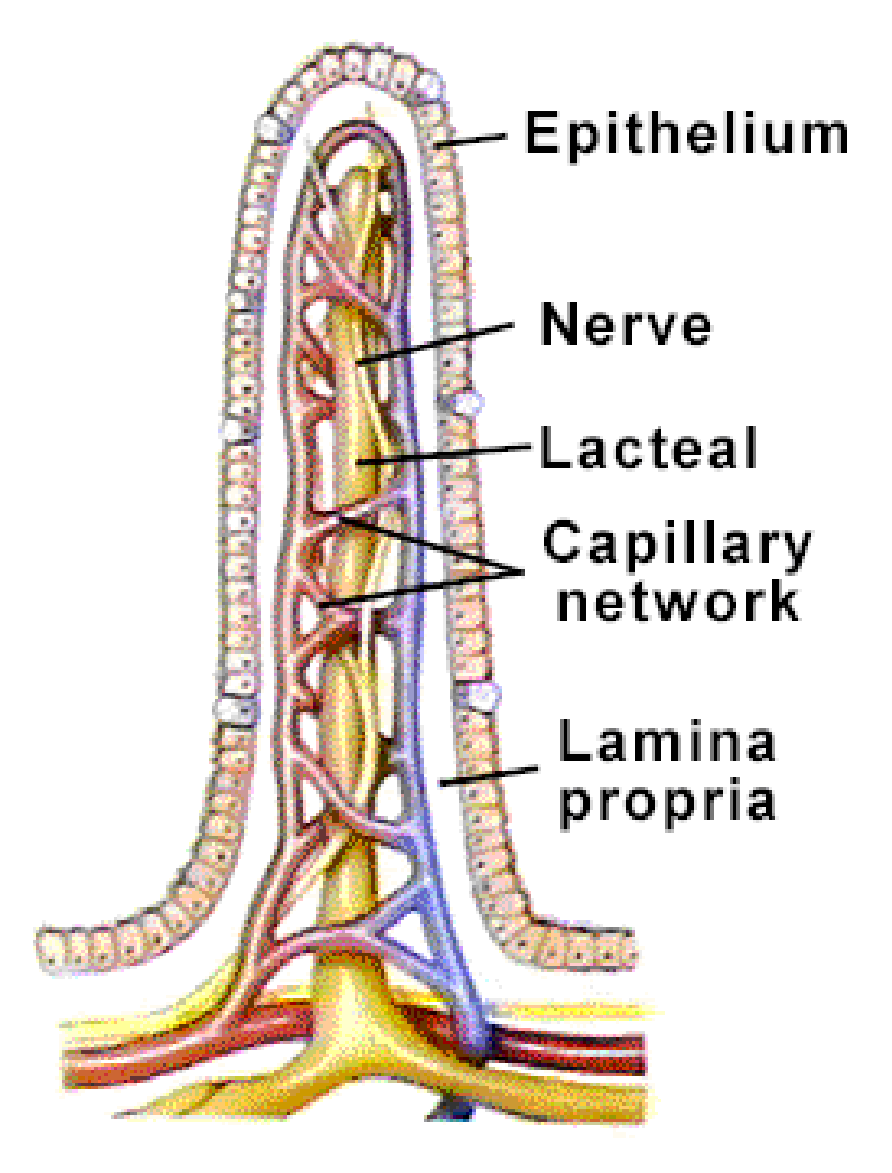
- Closed ends allow fluid flow inward only
  - Also bacteria, viruses, cancer cells
- Pick up and recycle extra tissue fluid
- The fluid flows to lymph nodes



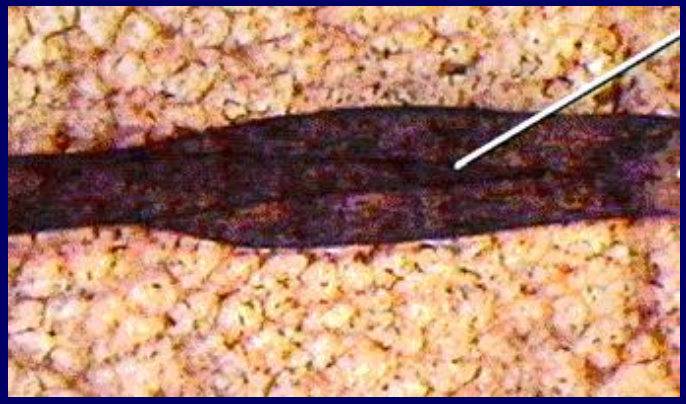
(a) Association of blood capillaries, tissue, and lymphatic capillaries

Lymph Capillaries

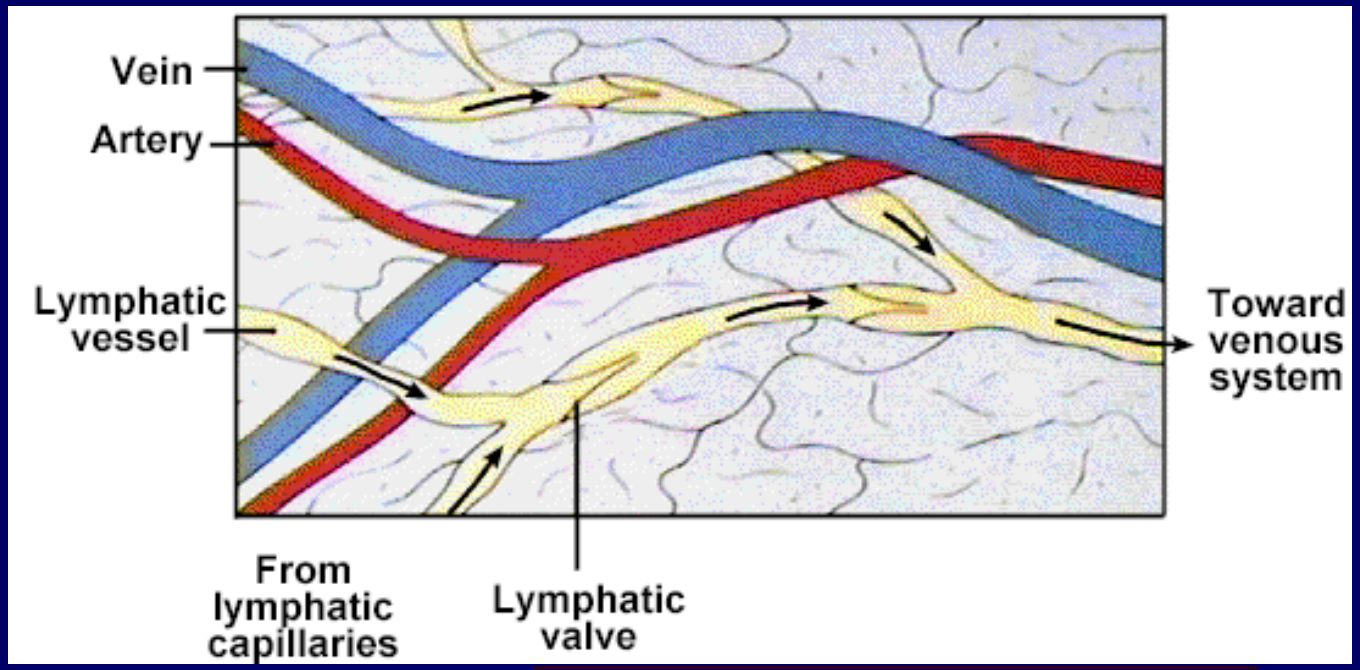
- Located everywhere, except for CNS, bone marrow, cornea and cartilage.
  - (XS fluid in CNS becomes part of CSF)
- Special set of lymph capillaries in villi of small intestine = Lacteals
  - Fat Absorption
  - To liver



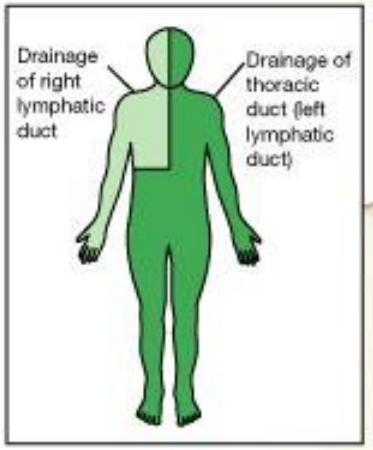
Lymphatic vessels



- Comparable in structure to capillaries, and in turn, veins. Thin walls!
- Hard to find in a general dissection



Damaged valves or blocked lymph vessels ⟹ edema



Right lymphatic duct

Right subclavian vein

Left subclavian vein

Thoracic (left lymphatic) duct

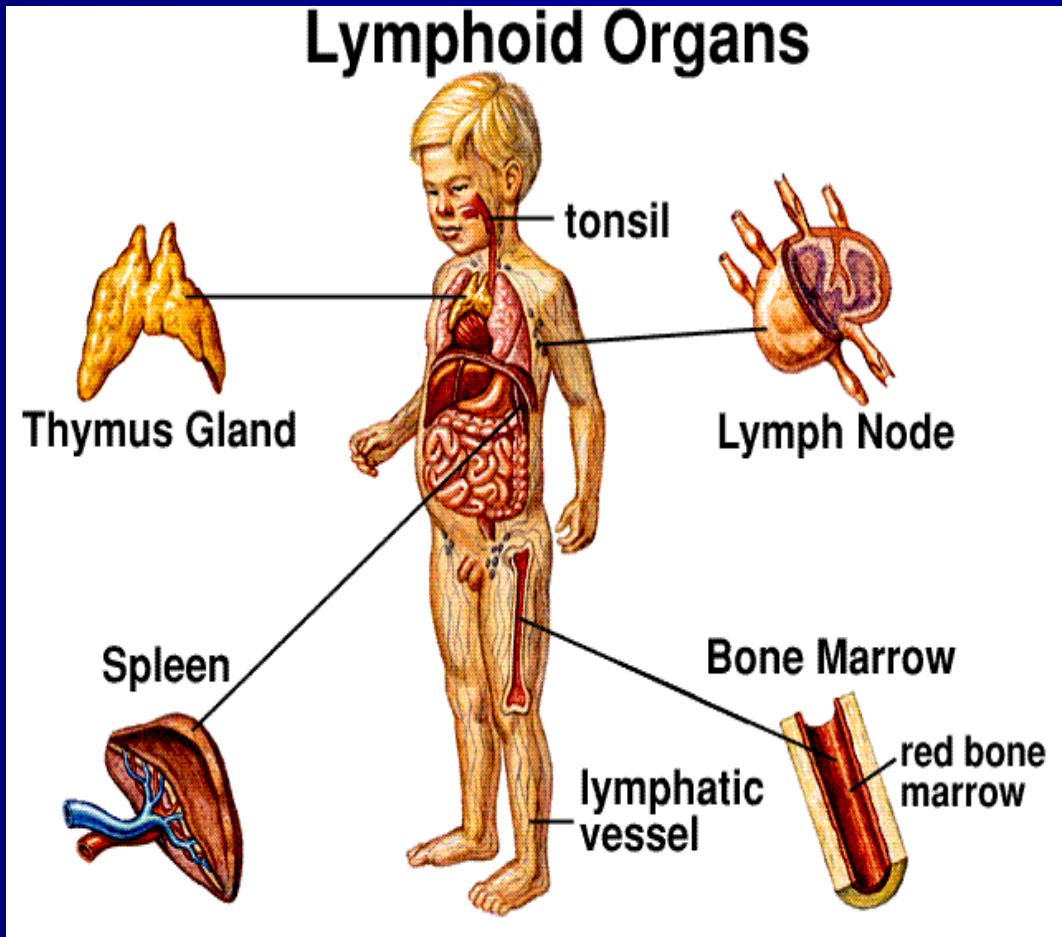
Cysterna Chyli

Left brachiocephalic vein
Left internal jugular vein
Left jugular trunk
Thoracic (left lymphatic) duct
Left subclavian trunk
Left bronchomediastinal trunk
First rib (cut)
Right bronchomediastinal trunk
Superior vena cava
Rib (cut)
Thoracic lymph nodes
Hemiazygos vein
Parietal pleura (cut)
Diaphragm
Intestinal trunk
Inferior vena cava
Left lumbar trunk
Right lumbar trunk

Lymph capillaries converge to become collecting vessels and end up as either Thoracic duct or right lymphatic duct

Lymphoid Organs

1. Lymph Nodes
    1. Lymph Nodules
        1. Tonsils
2. Thymus
3. Spleen
4. Bone Marrow
    1. Stem cells



1. Lymph Nodes

~ 500 (∅ 1mm to 25 mm)

Bean-shaped with hilus, cortex and medulla

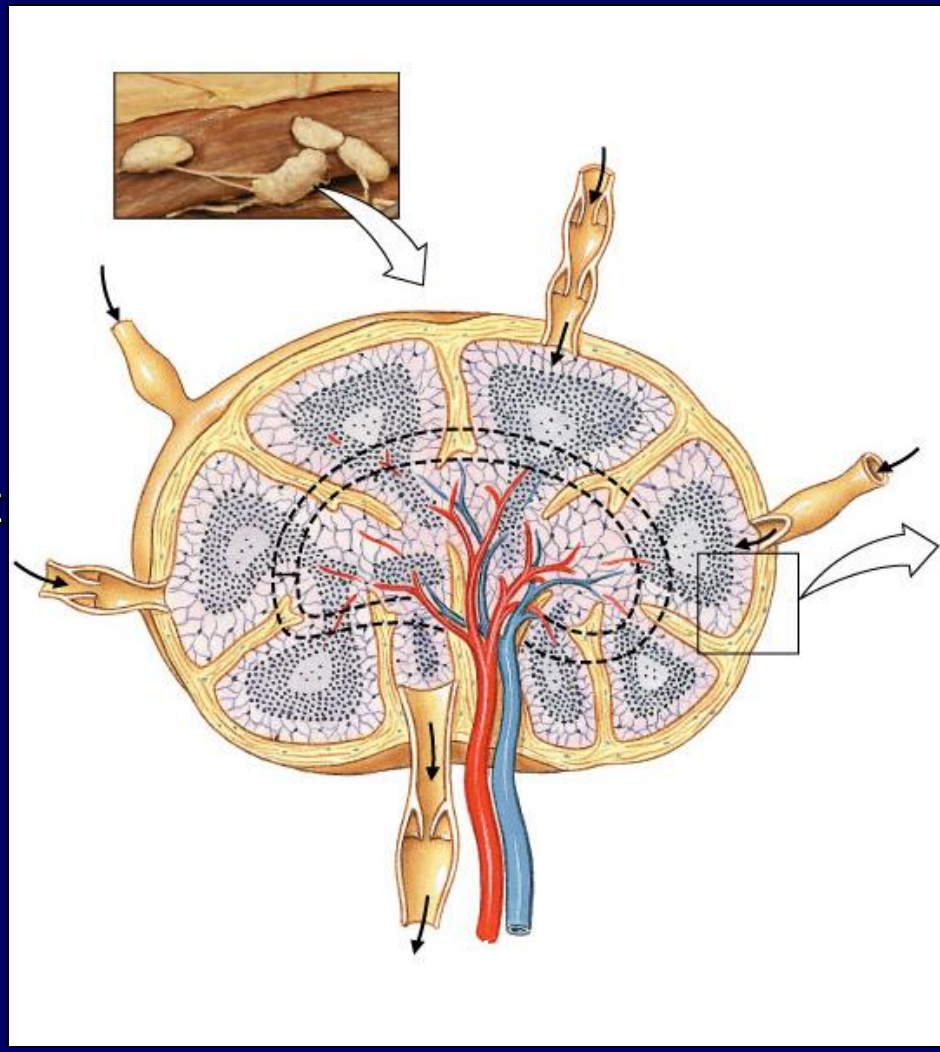
Several afferent vessels, one efferent vessel

Function: filter

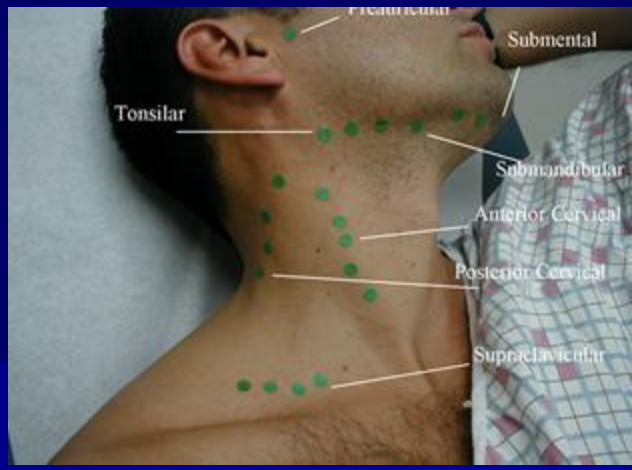
Popular term “lymph gland” is misnomer. Why?

Contain lots of Lymphocytes, Macrophages and Plasma Cells

Clinical application: Swollen lymph nodes



Distribution of LNs



Cervical lymph nodes - drain head and neck

Axillary lymph nodes - drain arms and breasts

Popliteal lymph nodes - drain legs

Inguinal lymph nodes - drain lower limb

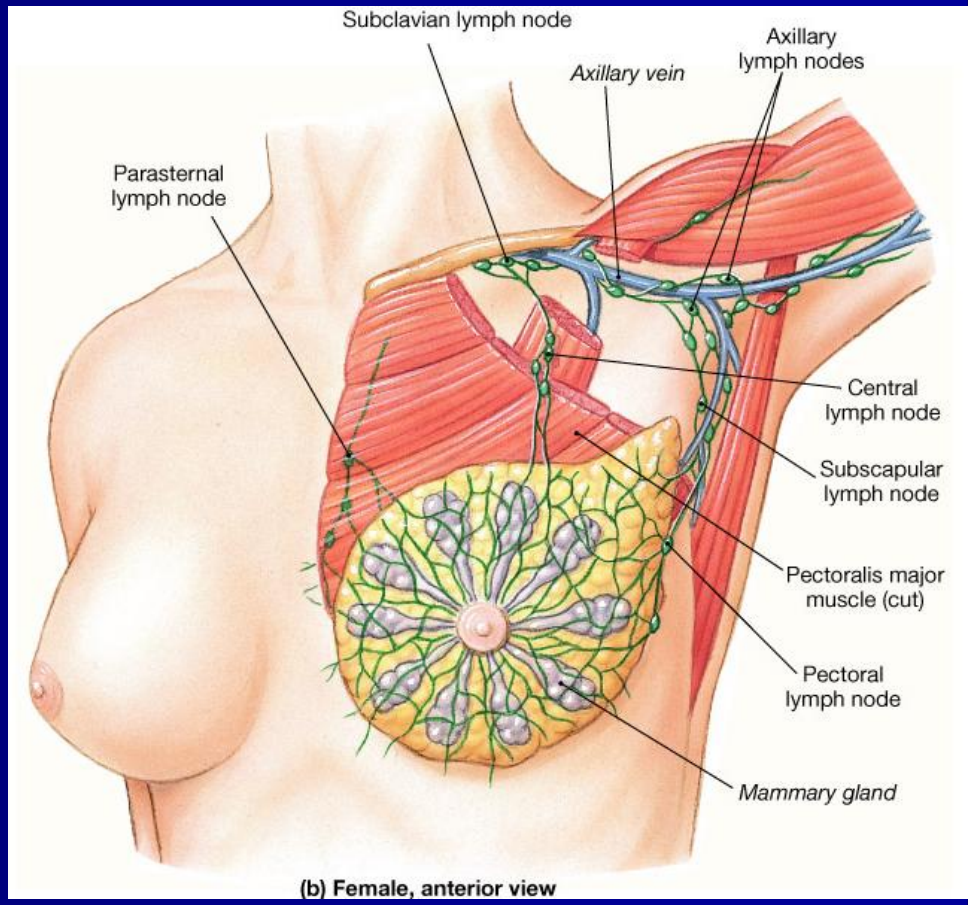
Thoracic lymph nodes - drain thoracic viscera

Abdominal lymph nodes - drain pelvic region

Intestinal and mesenteric lymph nodes - drain abdominal viscera

Important example: Axillary Drainage

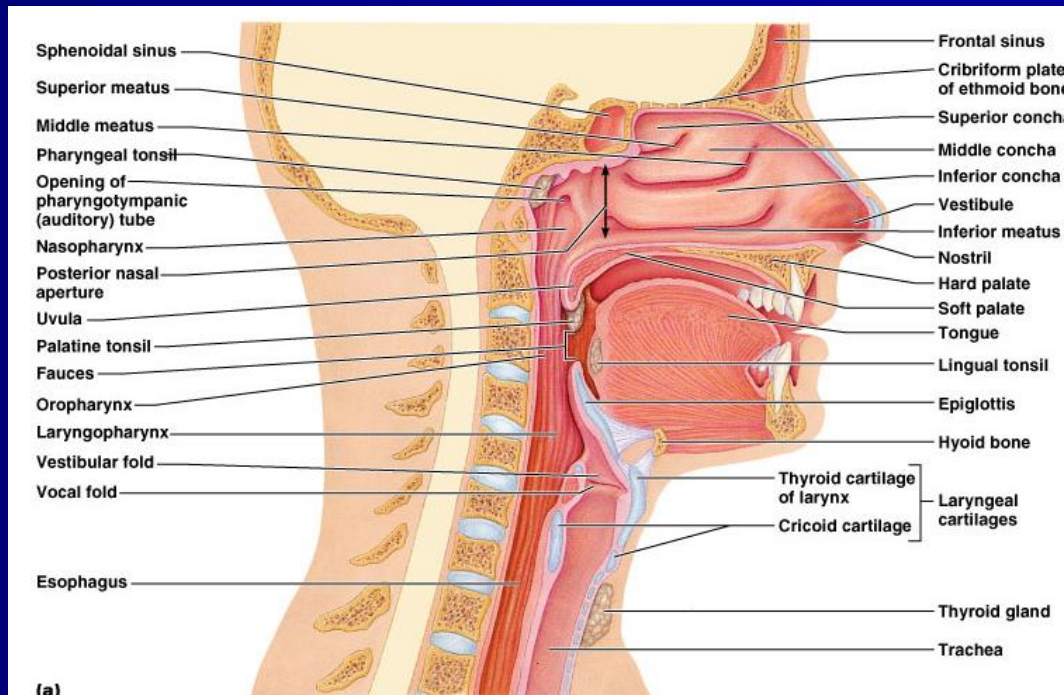
Drainage from breast and arm



Tonsils, p629

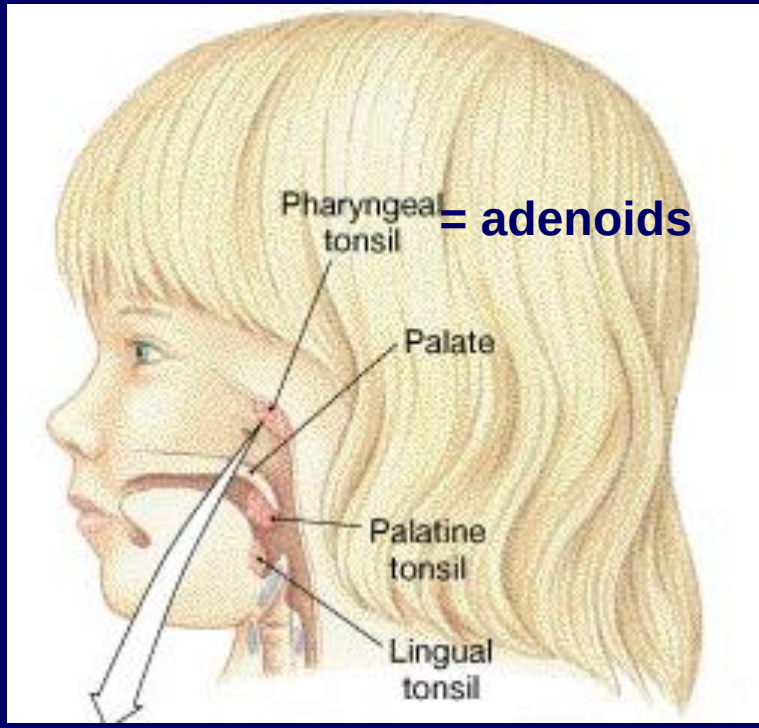
- Simple lymphoid organs
  - "Lymph nodules"
- In the mouth/pharynx
  - Lingual tonsil on posterior aspect of tongue
  - Palatine -- lateral pharynx, removed in tonsillectomy
  - Pharyngeal – AKA adenoids
  - Tubal, behind Eustachian Tubes

Fig 22.3, page 639

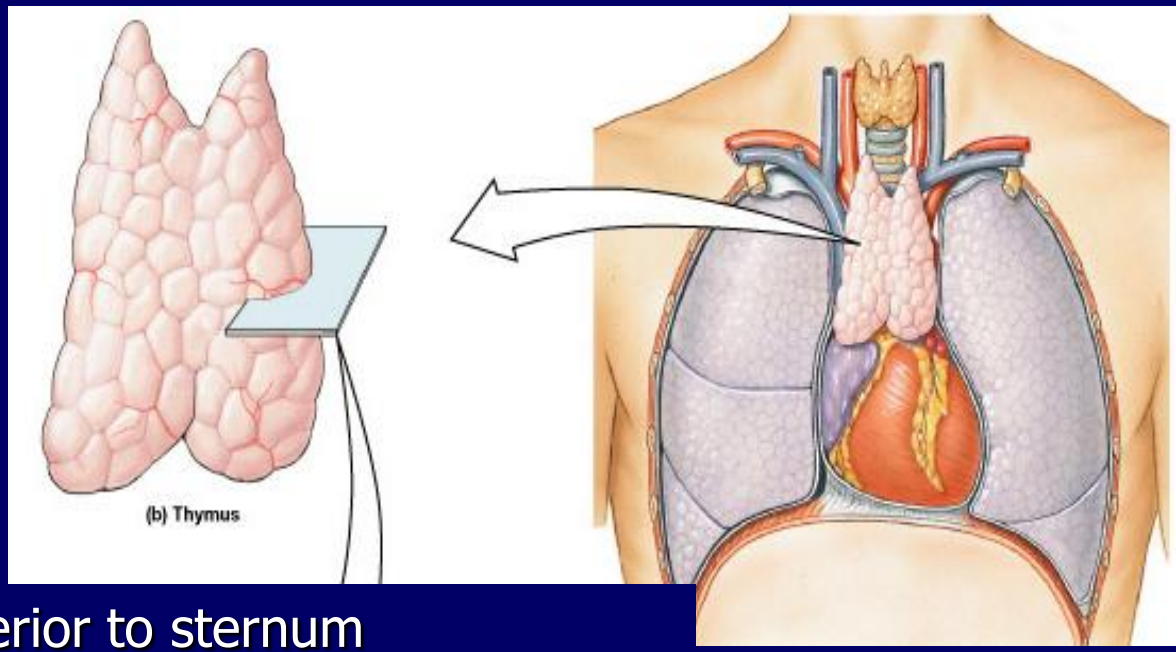


Lymphoid Tissue

- Connective tissue is loaded with lymphocytes
- Lymphoid nodules are unencapsulated clusters of lymphocytes (∅ ~ 1mm). Found beneath epithelial lining of respiratory, digestive & urinary tracts, etc.
- Mucosa Associated Lymphatic Tissue (MALT) in GI tract
  - 5 tonsils
  - aggregate lymphoid nodules in small intestine (= Peyer's patches)
  - appendix - walls contain lymphoid tissue



2. Thymus



Location above heart, posterior to sternum

Divided into lobules

Only lymphoid organ that does NOT fight antigens, it functions as "T-cell academy"

Involution after puberty

Epithelial cells produce thymic hormones, thymosin and thymopoetin

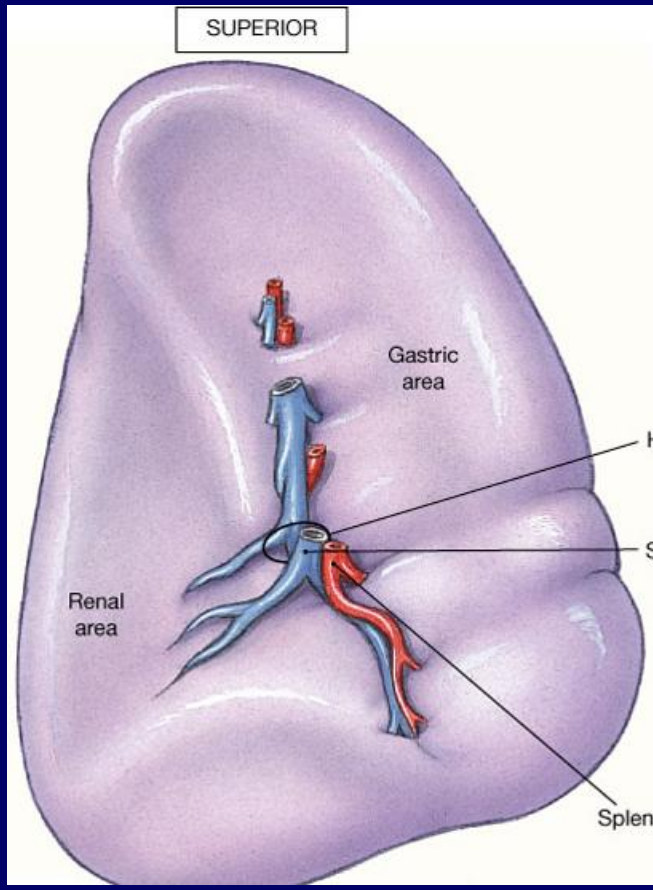
3. Spleen

Largest lymphoid organ, located in LUQ

Soft and very blood rich

Red pulp sinusoids containing RBCs

white pulp lymphoid tissue



Major Functions:

1. **Initiation of Immune response to antigens in blood**
2. **Removal of aged and defective RBCs, Fe salvaging**
3. **Reservoir for new RBCs**

4. Bone Marrow

Mostly in red marrow
From pluripotent stem cells

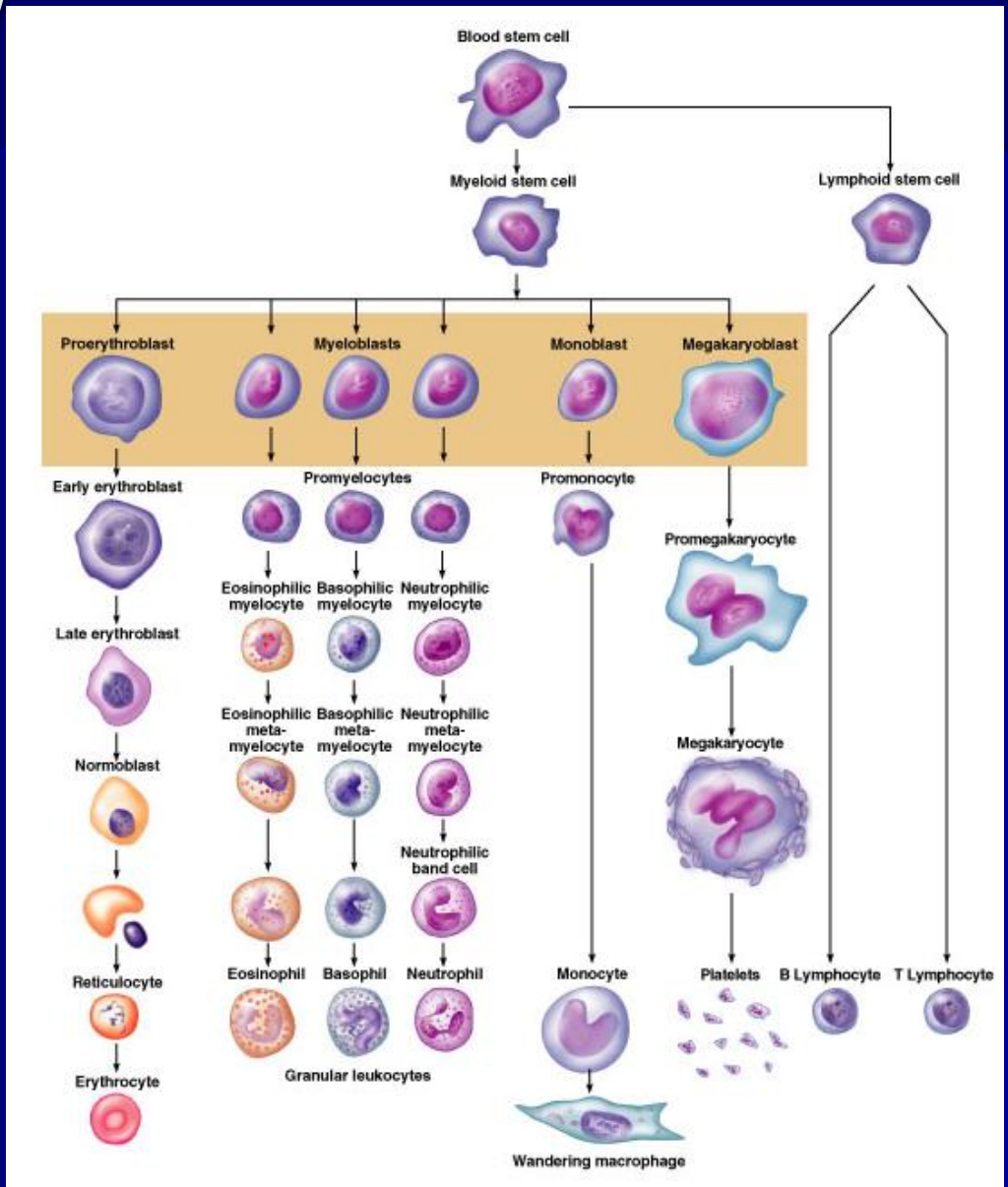
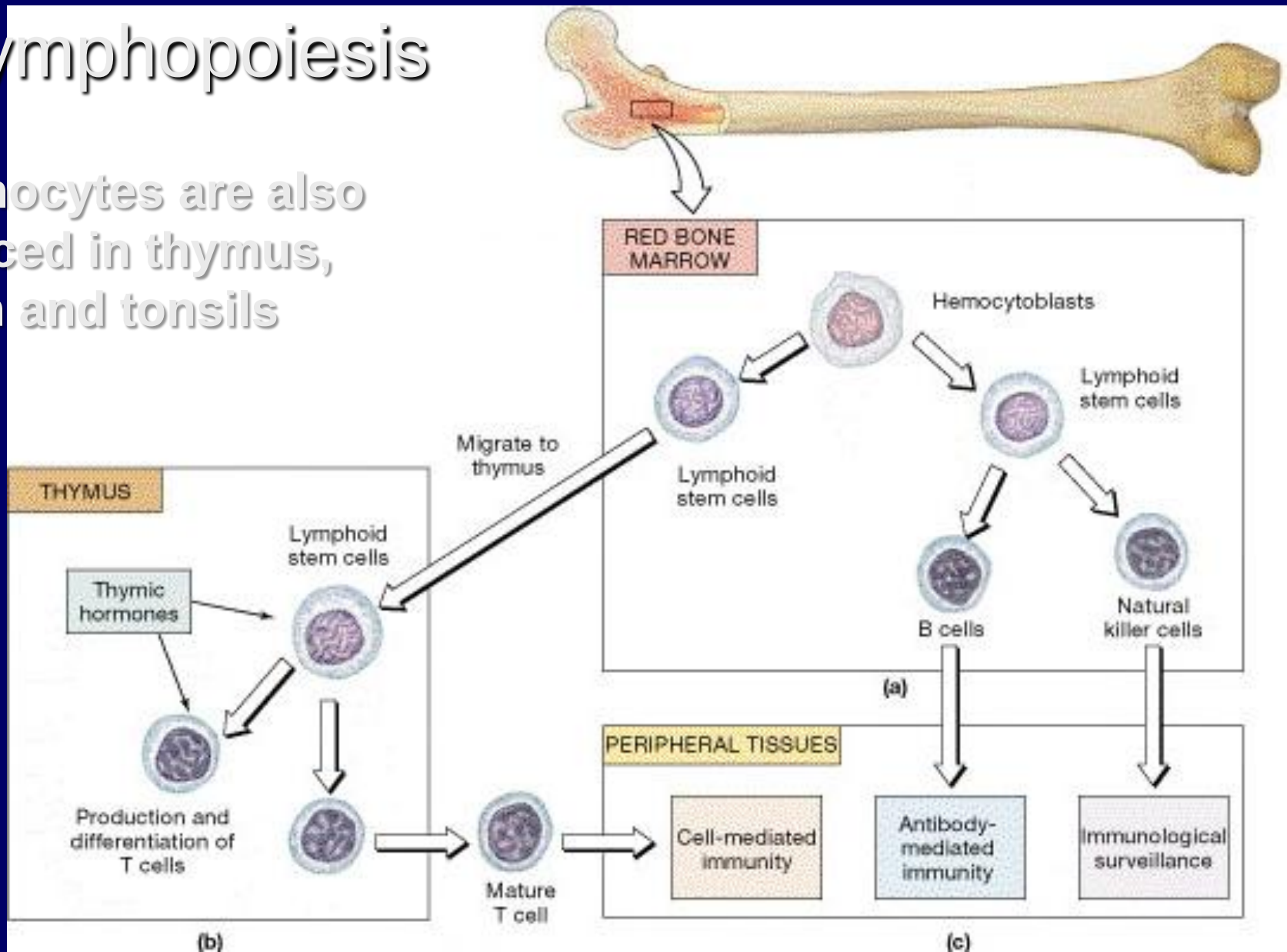


Fig. 17.8

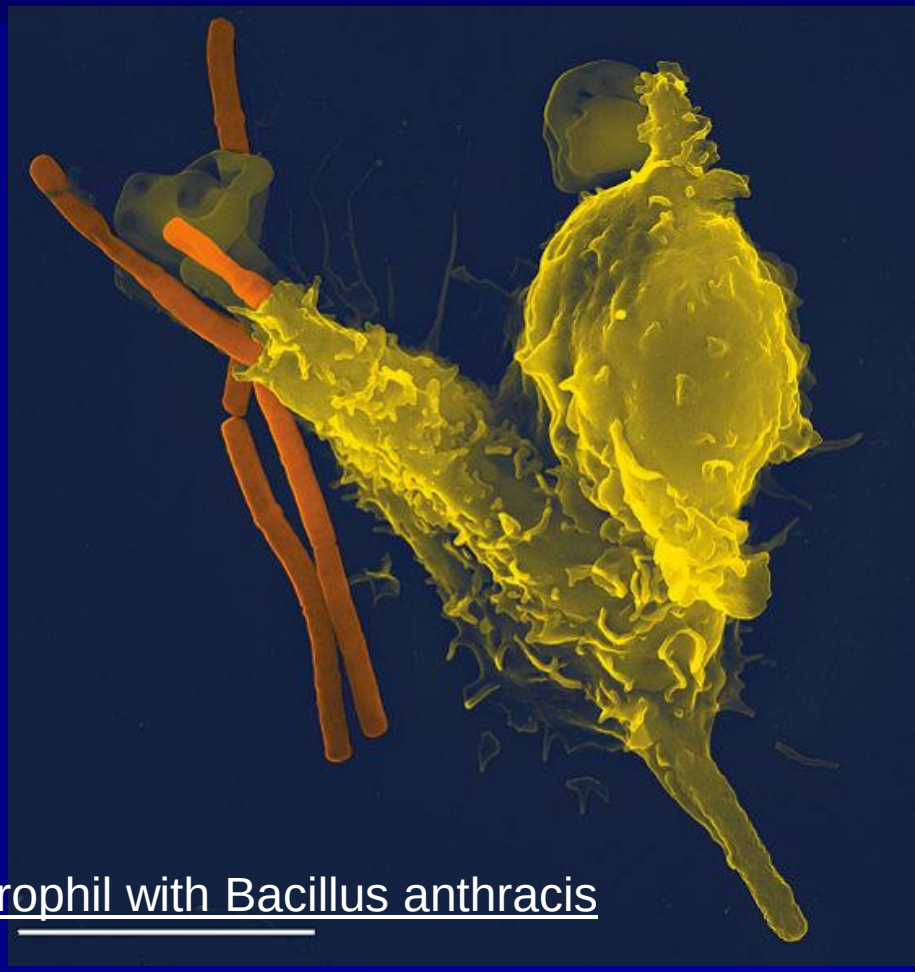
Bone Marrow: Lymphopoiesis

Lymphocytes are also produced in thymus, spleen and tonsils



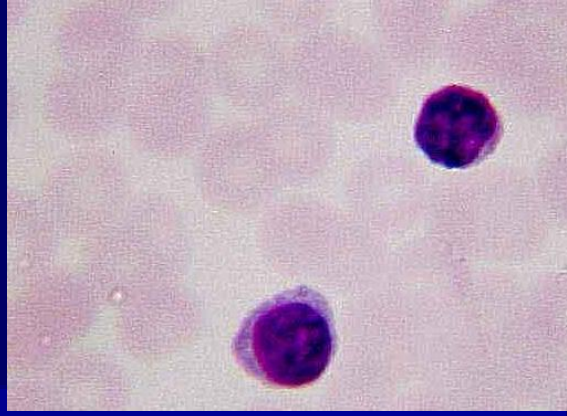
The Immune System

- The primary defense against disease
  - Infectious, especially
  - Specific
- Centered around the activity of lymphocytes
  - Other cells, too.



Neutrophil with Bacillus anthracis

Lymphocytes



Agranulocytes - large nuclei and small amount of cytoplasm

Function in identification and inactivation/destruction of pathogens

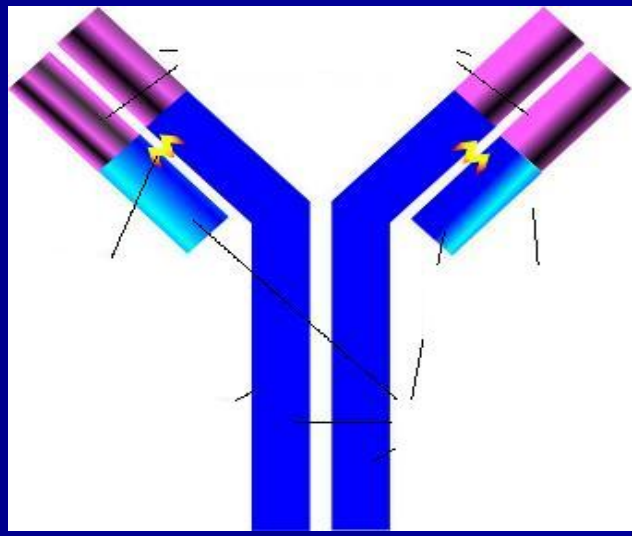
Types of Lymphocytes

1. T Cells - cellular immunity - specific for previously identified pathogens. AKA "cytotoxic cells."
2. B Cells - humoral immunity – become plasma cells, which produce antibodies specific to the antigen or pathogen; memory cells for future exposures
3. NK (Natural Killer) cells - non-specific, provide immunological surveillance, recognition of "non-self"

Antibodies (Ab)

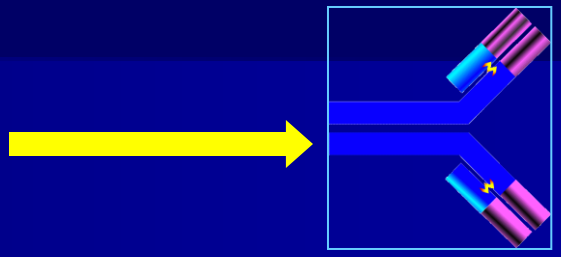
- AKA immunoglobulins (Ig)
- Proteins produced by plasma cells in response to a specific antigen (Ag)
  - Plasma cells are derived from B-lymphocytes
- Antibodies [Ab] frequently measured as a diagnostic tool
  - Serology

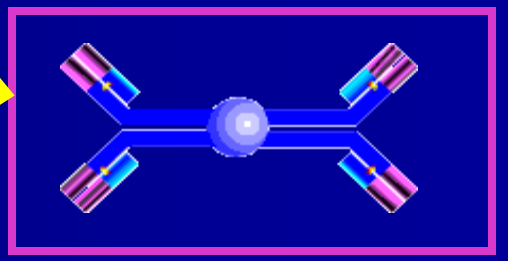
IgG

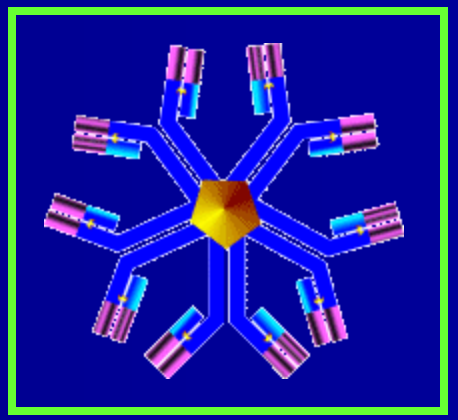


5 subclasses of Igs:

1. IgG: main Ab (75%) in serum; + main Ab during 2º response
2. IgA: main Ab in external secretions
3. IgE: main Ab in allergic reactions
4. IgM: Ab on virgin B-cells; + main Ab during 1º response
5. *IgD: Ab on virgin B-cells*







Sunset on the Atlantic Ocean